STORMWATER ANALYSIS

FOR

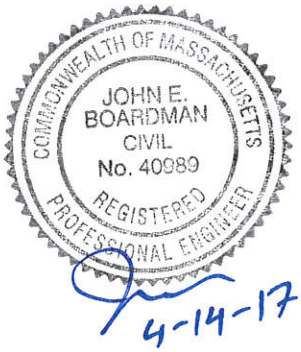
"Black Birch II"

Planned Residential Development

Forest Ridge Road
Concord, Mass.

PREPARED FOR:

Abode Builders of New England



Date: April 2017

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Introduction

Excerpt from MADEP Stormwater Management Standards Chapter 1:

In 1996, the Massachusetts Department of Environmental Protection (the "Department" or "MassDEP") issued the Stormwater Policy that established Stormwater Management Standards aimed at encouraging recharge and preventing stormwater discharges from causing or contributing to the pollution of the surface waters and groundwaters of the Commonwealth. In 1997, MassDEP published the Massachusetts Stormwater Handbook as guidance on the Stormwater Policy. MassDEP has revised the Stormwater Management Standards and Massachusetts Stormwater Handbook to promote increased stormwater recharge, the treatment of more runoff from polluting land uses, low impact development (LID) techniques, pollution prevention, the removal of illicit discharges to stormwater management systems, and improved operation and maintenance of stormwater best management practices (BMPs). MassDEP applies the Stormwater Management Standards pursuant to its authority under the Wetlands Protection Act, M.G.L. c. 131, § 40, and the Massachusetts Clean Waters Act, M.G.L .c. 21, §§ 26-53. The revised Stormwater Management Standards have been incorporated in the Wetlands Protection Act Regulations, 310 CMR 10.05(6)(k) and the Water Quality Certification Regulations, 314 CMR 9.06(6)(a).

Stormwater runoff results from rainfall and snow melt and represents the single largest source responsible for water quality impairments in the Commonwealth's rivers, lakes, ponds, and marine waters. New and existing development typically adds impervious surfaces and, if not properly managed, may alter natural drainage features, increase peak discharge rates and volumes, reduce recharge to wetlands and streams, and increase the discharge of pollutants to wetlands and water bodies.

The Stormwater Management Standards address water quality (pollutants) and water quantity (flooding, low base flow and recharge) by establishing standards that require the implementation of a wide variety of stormwater management strategies. These strategies include environmentally sensitive site design and LID techniques to minimize impervious surface and land disturbance, source control and pollution prevention, structural BMPs, construction period erosion and sedimentation control, and the long-term operation and maintenance of stormwater management systems.

Executive Summary

The existing site is located on the east side of Forest Ridge Road. The site is forested around the perimeter with a central grassed area. Stormwater runoff flows overland offsite to the perimeter and to existing catchbasins in the roadway to the Thoreau Club. This street drainage is then piped into the existing kettle hole and is contained within existing drainage easements.

The proposal calls for the construction of 8 single family units and 8 duplex units on a common driveway as part of a "Planned Residential Development" (PRD). In addition the drainage design accounts for the reconstruction of the adjacent parking lot and includes areas shown on the postdevelopment worksheet, "reserved for future parking" as paved in the post development scenario.

Stormwater runoff from the front of the homes, roads, and driveway will be collected via catchbasin manhole system and discharged to the existing naturalizes infiltration area (kettle hole). The backs of the proposed units will travel overland to promote infiltration towards the perimeter of the site. By reducing the total areas flowing towards the perimeter of the site and by maintaining overland flows the proposed offsite runoff rates are less than the existing rates. This design is in compliance with the MADEP stormwater management standards and incorporates best management practices (BMP's) consistent with low impact development (LID) and incorporates many of the concepts emphasized in LID.

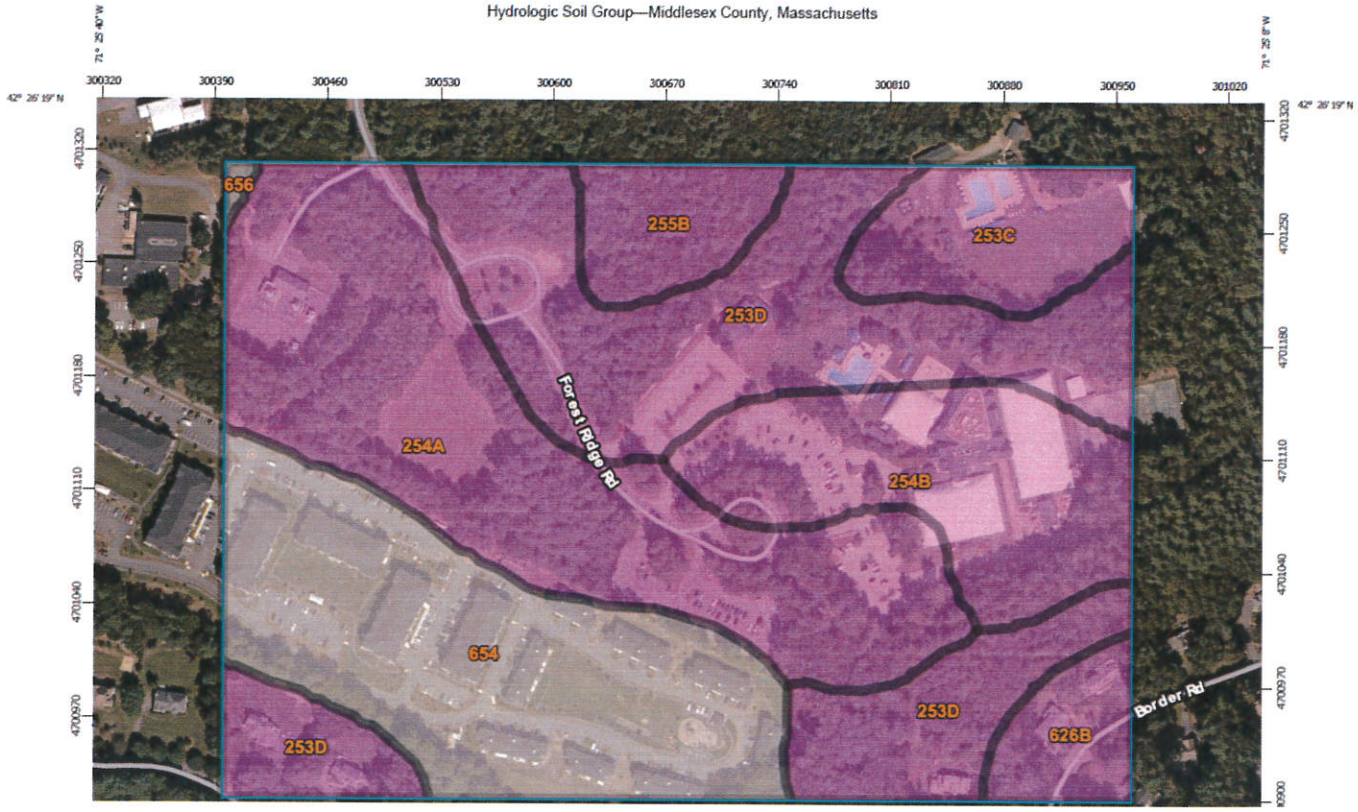
The intent of the closed drainage system design is to utilize the natural drainage patterns to the extent possible. The kettle hole provides a natural infiltration basin with the loam filtration which has been shown to function well based on the existing conditions at discharge points. This kettle hole is approximately 20-33' deep and shows no evidence of any ponding water, indicative of the natural infiltration capacity. There is no outlet from this basin other than infiltration through the bottom.

The existing kettle hole provides all the functionality of a typical infiltration basin – completely recharges the 100 year event in less than 72 hours, provides 100% recharge of all runoff. The deep layer of loam and organic soils are a filter which entraps any TSS remaining in the runoff. The lack of any signs of standing water indicates that the system is functioning. A sediment forebay will be constructed in the kettlehole at the bottom of slope below the outlet and has been sized according to MADEP standards.

Narrative – Existing Conditions

The existing site is located on the east side of Forest Ridge Road. The site is forested around the perimeter with a central grassed area. The site is generally flat with slight grade changes, with a high point of elevation 215 on the western property boundary low point of elevation of 209 along the eastern property line. The kettle hole located across the street has a bottom elevation of 173±. Stormwater runoff flows overland offsite to the perimeter and existing catchbasins in the roadway to the Thoreau Club. This street drainage is then piped into the existing kettle hole and is contained within existing drainage easements.

Soils onsite are mapped as Merrimac fine sandy loam (class a) by the USDA online mapping and this has been confirmed with onsite testing by this office.



Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
253C	Hinckley loamy sand, 8 to 15 percent slopes	A	3.3	6.0%
253D	Hinckley loamy sand, 15 to 25 percent slopes	A	15.4	28.1%
254A	Merrimac fine sandy loam, 0 to 3 percent slopes	A	14.1	25.6%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	6.7	12.2%
255B	Windsor loamy sand, 3 to 8 percent slopes	A	2.2	4.1%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	1.7	3.1%
654	Udorthents, loamy		11.4	20.7%
656	Udorthents-Urban land complex		0.1	0.2%
Totals for Area of Interest			**55.0**	**100.0%**

Narrative – Proposed Conditions

The proposal calls for the construction of a 8 single family units and 8 duplex units on a common driveway as part of a "Planned Residential Development" (PRD), The homes will be serviced by onsite sewer, town water, electric, telephone, gas and cable. In addition the drainage design accounts for the reconstruction of the adjacent parking lot and includes areas designated as "reserved for future parking" as paved in the post development scenario.

Stormwater runoff from the front of the homes, roads, and driveway will be collected via catchbasin manhole system and discharged to the existing naturalizes infiltration area (kettle hole). The backs of the proposed units will travel overland to promote infiltration towards the perimeter of the site. By reducing the total areas flowing towards the perimeter of the site and by maintaining overland flows the proposed offsite runoff rates are less than the existing rates. This design is in compliance with the MADEP stormwater management standards and incorporates best management practices (BMP's) consistent with low impact development (LID) and incorporates many of the concepts emphasized in LID.

The intent of the drainage design is to utilize the natural drainage patterns to the extent possible. The kettle hole provides a natural infiltration basin with the loam filtration which has been shown to function well based on the existing conditions at discharge points. This kettle hole is approximately 20-33' deep and shows no evidence of any ponding water, indicative of the natural infiltration capacity. There is no outlet from this basin other than infiltration through the bottom.

The existing kettle hole provides all the functionality of a typical infiltration basin – completely recharges the 100 year event in less than 72 hours, provides 100% recharge of all runoff. The deep layer of loam and organic soils are a filter which entraps any TSS remaining in the runoff. The lack of any signs of standing water indicates that the system is functioning.

The proposed Black Birch project will discharge runoff into the same swales in the kettle hole. Runoff will be pretreated with deep sump catchbasins and oil and grease hoods. A sediment forebay will be constructed at the bottom of slope below the outlet and has been sized according to MADEP standards.

BMP's utilized:

- Deep sump catchbasins
- Vegetated grass filter strips / overland flow
- Infiltration basins (natural)

LID techniques utilized:

- *Maintain as much of the pre-development vegetation as possible*
- *Maintain natural buffers and drainage ways*
- *Minimize placement of new structures or roads over porous or erodible soils*
- *Reduce frontage and other setbacks*
- *Preserve and use natural drainage systems*

Documenting Compliance

Standard 1 - No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

Stormwater velocity at all outlets are included in the HydroCAD data and all outlets shall be provided with a rip-rap apron to resist erosion.

Standard 2 - Stormwater management systems shall be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates...To prevent storm damage and downstream and off-site flooding, Standard 2 requires that the post-development peak discharge rate is equal to or less than the pre-development rate from the 2-year and the 10-year 24-hour storms...Proponents must also evaluate the impact of peak discharges from the 100-year 24-hour storm. If this evaluation shows that increased off-site flooding will result from peak discharges from the 100-year 24-hour storms, BMPs must also be provided to attenuate these discharges.

The site has been designed to have no increase in offsite runoff for the 2-year and 10-year storm and the 100-year storm

Analysis Point 1, Offsite to the Southwest

	2-year 24-hour Storm (3.2 inches) cfs	10-year 24-hour Storm (4.5 inches) cf	100-year 24-hour Storm (6.5 inches) cfs
Pre-development to the Southwest (Subcat 1s)	0.0	0.1	1.3
Post-development to the Southwest (Subcat 10s)	0.0	0.0	0.5

Analysis Point 2, Offsite to the Existing Roadway Drainage System

	2-year 24-hour Storm (3.2 inches) cfs	10-year 24-hour Storm (4.5 inches) cf	100-year 24-hour Storm (6.5 inches) cfs
Pre-development to the Roadway (Reach 7r)	1.9	3.4	6.0
Post-development to the Roadway (Reach 20r)	1.4	2.5	4.9

The runoff to the low point (Pond 6p) is fully contained within the kettle hole depression. Theoretical 100 year ponding is elevation 181.0 in the predevelopment and 182.8 in the post development with no impact.

Standard 3 - Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

Total impervious Area onsite = 4.6± acres (includes Thoreau Parking Lots) = 200,000± sq.ft.
Class A soils = 0.6 inches x impervious area
Required recharge = 200,000 x 0.6 inches = 10,000 cubic feet
Capture Area Adjustment
0.1 acres impervious not tributary to infiltration basin
4.5 acres impervious tributary to infiltration basin
Capture adjustment factor = total area / tributary area = 4.6/4.5 = 1.02
Required recharge = 1.02 x 10,000 = **10,200 cubic feet**

Static Recharge provided (actual volume stored, see HydroCAD output - 100 year)
Infiltration Basin 72,000± cubic feet
Total recharge provided = **72,000 cubic feet**

Drawdown Time: 10,200 cubic feet / (2.41in/hr x 7,500sq.ft. x 1/12ft/in) = **6.8 hours**
Groundwater offsets are greater than four feet and mounding analysis is not required.

Standard 4 - Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

Naturalized Infiltration Areas

		Removal Rate	Remains	
Pretreatment	Deep sump hooded catch basins	25%	75%	
Treatment	Infiltration w/ forebay	80 %	15%	
Final Rate			**85%**	removal

The design conservatively assumes that the naturalized infiltration area is not an area of rapid infiltration due to thick layer of existing topsoil, and have been modeled with a Rawl's rate of 2.41 inches per hour. This sandy loam is similar to the filtration media for a rain garden and as evidenced by the current conditions with runoff receiving no pre-treatment, there are no issues with TSS resulting in a loss of natural recharge capacity in the kettle hole. It should be noted that there are no sensitive receptors in the kettle hole and that the natural capacity far exceeds the runoff generated from any of the design storms.

BMP Sizing
Naturalized Infiltration Area
Infiltration areas should contain the required water quality volume.
WQV = 1.0 inch x 4.6 acres impervious = **16,698 cubic feet required**
Volume provided = **72,000 cubic feet provided** (see hydrocad output)

Standard 5 - For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

The site does not qualify as a land uses with higher potential pollutant loads.

Standard 6 - Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.

This site does not discharge to a critical area.

Standard 7 - A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

The site is not being proposed as a redevelopment project.

Standard 8 - A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

See draft Stormwater Pollution Prevention Plan included in this document. This document is draft only as the final document will include contact information on the site contractor and may have some minor modifications to reflect the contractor's equipment and construction schedule.

Standard 9 - A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

See the Operation and Maintenance Plan included in this document.

Standard 10 - All illicit discharges to the stormwater management system are prohibited.

Illicit Discharge Compliance Statement

To the best of my knowledge no illicit discharges currently exist on the site and no future illicit discharge will be allowed, including wastewater discharges and discharges of stormwater contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease.

_____

Signature of Owner Date

To be completed and submitted prior to the start of construction.

Stormwater Operation and Maintenance Plan - Long Term Pollution Prevention

Ongoing maintenance is required for the proper function of the stormwater management system allowing the system prevent pollution for the long term. This document provides a guideline for this work and allows for record keeping.

Stormwater Management System Owner: TO BE DETERMINED

Party Responsible for Maintenance: TO BE DETERMINED

Snow Removal

Snow removal from private right of ways and private lots will be the responsibility of the homeowners. Snow should not be plowed or stockpiled in raingardens, sediment forebays, or infiltration basins.

Public Safety Features

The site has been designed with sidewalks and crosswalks to allow for safe movement throughout the site.

Preliminary Stormwater O&M Maintenance Budget

Inspection and maintenance = $2,000 x 4 times per year = $8,000±

Site Specific BMP Maintenance Plans

(Reference MADEP Volume 2, Chapter – Structural BMP Specifications for the Massachusetts Stormwater Handbook)

Deep Sump/Hooded Catchbasins

Inspect and clean deep sump basins 4 times per year.

If handling runoff from land uses with higher potential pollutant loads or discharging runoff near or to a critical area, more frequent cleaning may be necessary. Clamshell buckets are typically used to remove sediment in Massachusetts. However, vacuum trucks are preferable, because they remove more trapped sediment and supernatant than clamshells. Vacuuming is also a speedier process and is less likely to snap the cast iron hood within the deep sump catch basin. Structural BMPs. Although catch basin debris often contains concentrations of oil and hazardous materials such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Unless there is evidence that they have been contaminated by a spill or other means, MassDEP does not routinely require catch basin cleanings to be tested before disposal.

Infiltration Basin

Inspect and complete preventive maintenance at least twice a year. Inspect the pretreatment BMPs per previous sections. Once the outlets from the Black Birch drainage system is functional, inspect it after every major storm for the first few months to ensure it is stabilized and functioning properly and if necessary take corrective action. Note how long water remains standing in the basin after a storm; standing water within the basin 48 to 72 hours after a storm indicates that the infiltration capacity may have been overestimated. If the ponding is due to clogging, immediately address the reasons for the clogging (such as upland sediment erosion, excessive compaction of soils, or low spots). Thereafter, inspect the infiltration basin (kettle hole) at least twice per year. Important items to check during the inspection include:

- Signs of differential settlement
- Cracking
- Erosion
- Condition of riprap
- Sediment accumulation at the beyond the concrete swales.

Sediment Forebay

At least four times a year, inspect the low area in the kettle hole and remove trash and debris at the same time. If there are any signs of sediment accumulation or standing water in the low point, remove sediment and underlying organic leaf litter using hand tools such as rakes and shovels surficial. Check for signs of rilling and gullying and repair as needed. The intent is to improve the infiltrative capacity while maintaining the existing vegetation so care must be used to not damage existing trees and vegetation. Remove sediment from the basin as necessary, but wait until the floor of the basin is thoroughly dry. Use light equipment to access the location so as to not compact the surrounding soils. Inspect and clean pretreatment devices per O&M sections above.

Stormwater BMP Inspection and Maintenance Log
(print a log for each BMP and maintain a log book for the project)

BMP:_____

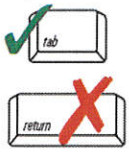
Date	Inspector	Issues Observed	Corrective Action Taken	Notes

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

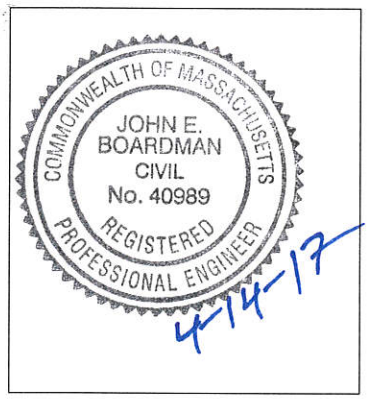
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☒ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

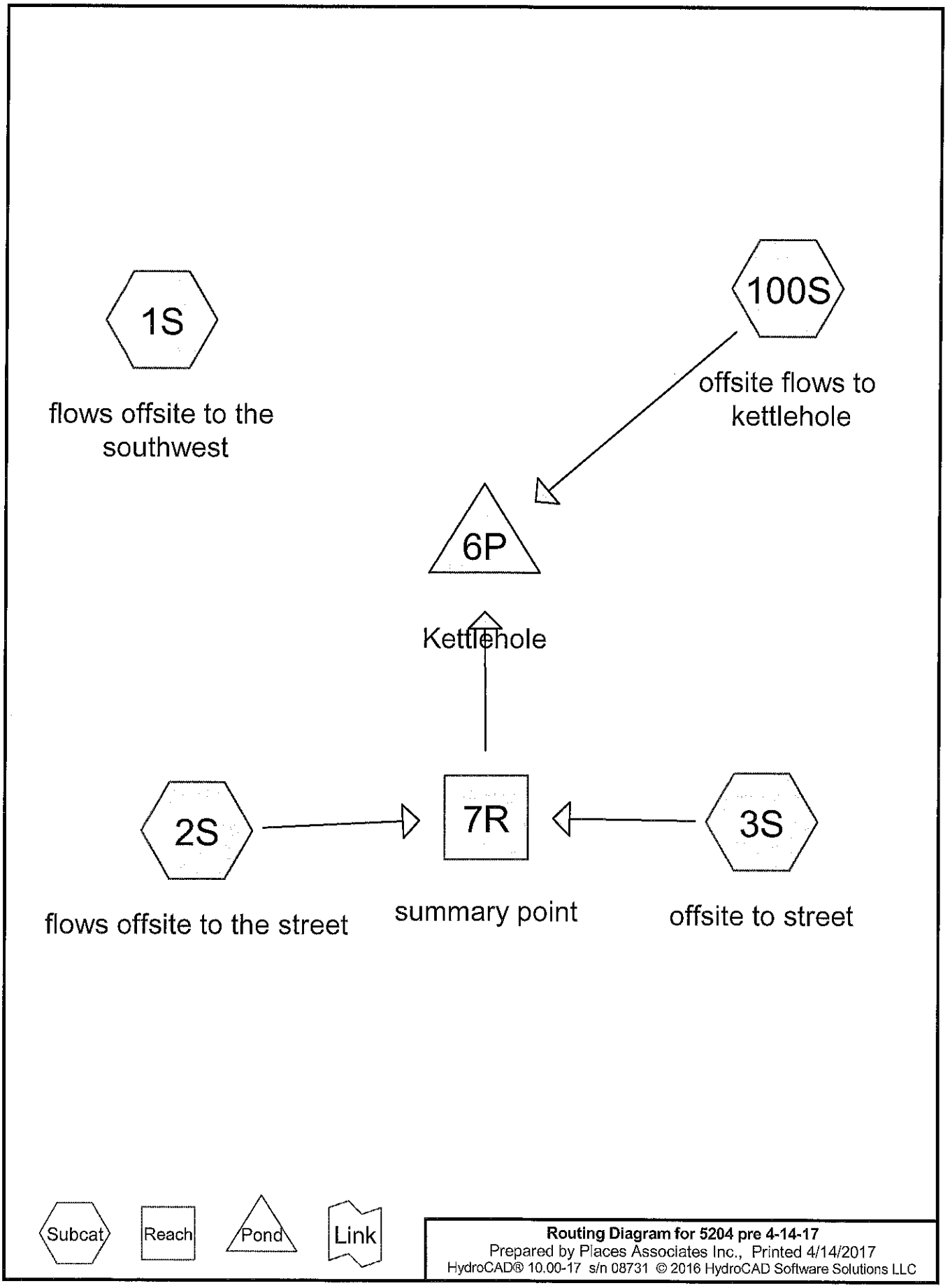
- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☒ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.


1S
flows offsite to the southwest
100S
offsite flows to kettlehole
6P
Kettlehole
2S
flows offsite to the street
7R
summary point
3S
offsite to street
Subcat
Reach
Pond
Link
Routing Diagram for 5204 pre 4-14-17
Prepared by Places Associates Inc., Printed 4/14/2017
HydroCAD® 10.00-17 s/n 08731 © 2016 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.350	49	50-75% Grass cover, Fair, HSG A (1S, 2S, 3S, 100S)
3.200	98	Paved parking, HSG A (3S, 100S)
6.950	36	Woods, Fair, HSG A (1S, 2S, 3S, 100S)
12.500	**54**	**TOTAL AREA**

Summary for Subcatchment 1S: flows offsite to the southwest

Runoff = 0.0 cfs @ 23.99 hrs, Volume= 0.001 af, Depth> 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Description
1.300	49	50-75% Grass cover, Fair, HSG A
3.200	36	Woods, Fair, HSG A
4.500	40	Weighted Average
4.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.5	350	Total			

Summary for Subcatchment 2S: flows offsite to the street

Runoff = 0.0 cfs @ 24.06 hrs, Volume= 0.000 af, Depth> 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Description
0.300	49	50-75% Grass cover, Fair, HSG A
0.800	36	Woods, Fair, HSG A
1.100	40	Weighted Average
1.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
28.9	145	0.0200	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
39.4	195	Total			

Summary for Subcatchment 3S: offsite to street

Runoff = 1.9 cfs @ 12.10 hrs, Volume= 0.138 af, Depth= 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Description
0.800	98	Paved parking, HSG A
0.150	36	Woods, Fair, HSG A
0.350	49	50-75% Grass cover, Fair, HSG A
1.300	78	Weighted Average
0.500		38.46% Pervious Area
0.800		61.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 100S: offsite flows to kettlehole

Runoff = 2.7 cfs @ 12.12 hrs, Volume= 0.261 af, Depth= 0.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Description
2.400	98	Paved parking, HSG A
2.800	36	Woods, Fair, HSG A
0.400	49	50-75% Grass cover, Fair, HSG A
5.600	64	Weighted Average
3.200		57.14% Pervious Area
2.400		42.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 7R: summary point

Inflow Area = 2.400 ac, 33.33% Impervious, Inflow Depth = 0.69" for 2 year event
Inflow = 1.9 cfs @ 12.10 hrs, Volume= 0.138 af
Outflow = 1.9 cfs @ 12.10 hrs, Volume= 0.138 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Summary for Pond 6P: Kettlehole

Inflow Area = 8.000 ac, 40.00% Impervious, Inflow Depth = 0.60" for 2 year event
Inflow = 4.6 cfs @ 12.11 hrs, Volume= 0.399 af
Outflow = 0.3 cfs @ 15.52 hrs, Volume= 0.318 af, Atten= 93%, Lag= 204.6 min
Discarded = 0.3 cfs @ 15.52 hrs, Volume= 0.318 af

Routing by Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 176.47' @ 15.52 hrs Surf.Area= 5,243 sf Storage= 8,282 cf

Plug-Flow detention time= 294.3 min calculated for 0.318 af (80% of inflow)

Center-of-Mass det. time= 209.1 min (1,091.7 - 882.6)

Volume	Invert	Avail.Storage	Storage Description
#1	173.00'	110,561 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
173.00	77	0	0
174.00	505	291	291
175.00	3,182	1,844	2,135
176.00	4,540	3,861	5,996
177.00	6,045	5,293	11,288
178.00	7,500	6,773	18,061
180.00	10,000	17,500	35,561
185.00	20,000	75,000	110,561

Device	Routing	Invert	Outlet Devices
#1	Discarded	173.00'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 163.00'

Discarded OutFlow Max=0.3 cfs @ 15.52 hrs HW=176.47' (Free Discharge)
↑**1=Exfiltration** (Controls 0.3 cfs)

Summary for Subcatchment 1S: flows offsite to the southwest

Runoff = 0.1 cfs @ 13.99 hrs, Volume= 0.051 af, Depth> 0.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Description
1.300	49	50-75% Grass cover, Fair, HSG A
3.200	36	Woods, Fair, HSG A
4.500	40	Weighted Average
4.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.5	350	Total			

Summary for Subcatchment 2S: flows offsite to the street

Runoff = 0.0 cfs @ 14.85 hrs, Volume= 0.012 af, Depth> 0.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Description
0.300	49	50-75% Grass cover, Fair, HSG A
0.800	36	Woods, Fair, HSG A
1.100	40	Weighted Average
1.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
28.9	145	0.0200	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
39.4	195	Total			

Summary for Subcatchment 3S: offsite to street

Runoff = 3.4 cfs @ 12.09 hrs, Volume= 0.248 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Description
0.800	98	Paved parking, HSG A
0.150	36	Woods, Fair, HSG A
0.350	49	50-75% Grass cover, Fair, HSG A
1.300	78	Weighted Average
0.500		38.46% Pervious Area
0.800		61.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 100S: offsite flows to kettlehole

Runoff = 7.5 cfs @ 12.10 hrs, Volume= 0.591 af, Depth= 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Description
2.400	98	Paved parking, HSG A
2.800	36	Woods, Fair, HSG A
0.400	49	50-75% Grass cover, Fair, HSG A
5.600	64	Weighted Average
3.200		57.14% Pervious Area
2.400		42.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 7R: summary point

Inflow Area = 2.400 ac, 33.33% Impervious, Inflow Depth > 1.30" for 10 year event
Inflow = 3.4 cfs @ 12.09 hrs, Volume= 0.261 af
Outflow = 3.4 cfs @ 12.09 hrs, Volume= 0.261 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Summary for Pond 6P: Kettlehole

Inflow Area = 8.000 ac, 40.00% Impervious, Inflow Depth = 1.28" for 10 year event
Inflow = 10.9 cfs @ 12.10 hrs, Volume= 0.852 af
Outflow = 0.5 cfs @ 15.96 hrs, Volume= 0.546 af, Atten= 95%, Lag= 231.4 min
Discarded = 0.5 cfs @ 15.96 hrs, Volume= 0.546 af

Routing by Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 178.36' @ 15.96 hrs Surf.Area= 7,955 sf Storage= 20,875 cf

Plug-Flow detention time= 351.0 min calculated for 0.546 af (64% of inflow)

Center-of-Mass det. time= 234.8 min (1,097.1 - 862.3)

Volume	Invert	Avail.Storage	Storage Description
#1	173.00'	110,561 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
173.00	77	0	0
174.00	505	291	291
175.00	3,182	1,844	2,135
176.00	4,540	3,861	5,996
177.00	6,045	5,293	11,288
178.00	7,500	6,773	18,061
180.00	10,000	17,500	35,561
185.00	20,000	75,000	110,561

Device	Routing	Invert	Outlet Devices
#1	Discarded	173.00'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 163.00'

Discarded OutFlow Max=0.5 cfs @ 15.96 hrs HW=178.36' (Free Discharge)
1=Exfiltration (Controls 0.5 cfs)

Summary for Subcatchment 1S: flows offsite to the southwest

Runoff = 1.3 cfs @ 12.49 hrs, Volume= 0.248 af, Depth> 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Description
1.300	49	50-75% Grass cover, Fair, HSG A
3.200	36	Woods, Fair, HSG A
4.500	40	Weighted Average
4.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.5	350	Total			

Summary for Subcatchment 2S: flows offsite to the street

Runoff = 0.2 cfs @ 12.76 hrs, Volume= 0.061 af, Depth> 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Description
0.300	49	50-75% Grass cover, Fair, HSG A
0.800	36	Woods, Fair, HSG A
1.100	40	Weighted Average
1.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
28.9	145	0.0200	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
39.4	195	Total			

Summary for Subcatchment 3S: offsite to street

Runoff = 6.0 cfs @ 12.09 hrs, Volume= 0.436 af, Depth= 4.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Description
0.800	98	Paved parking, HSG A
0.150	36	Woods, Fair, HSG A
0.350	49	50-75% Grass cover, Fair, HSG A
1.300	78	Weighted Average
0.500		38.46% Pervious Area
0.800		61.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 100S: offsite flows to kettlehole

Runoff = 16.6 cfs @ 12.10 hrs, Volume= 1.226 af, Depth= 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Description
2.400	98	Paved parking, HSG A
2.800	36	Woods, Fair, HSG A
0.400	49	50-75% Grass cover, Fair, HSG A
5.600	64	Weighted Average
3.200		57.14% Pervious Area
2.400		42.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 7R: summary point

Inflow Area = 2.400 ac, 33.33% Impervious, Inflow Depth > 2.48" for 100 year event
Inflow = 6.0 cfs @ 12.09 hrs, Volume= 0.497 af
Outflow = 6.0 cfs @ 12.09 hrs, Volume= 0.497 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Summary for Pond 6P: Kettlehole

Inflow Area = 8.000 ac, 40.00% Impervious, Inflow Depth > 2.58" for 100 year event
Inflow = 22.6 cfs @ 12.10 hrs, Volume= 1.722 af
Outflow = 0.9 cfs @ 16.36 hrs, Volume= 0.905 af, Atten= 96%, Lag= 256.0 min
Discarded = 0.9 cfs @ 16.36 hrs, Volume= 0.905 af

Routing by Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 181.04' @ 16.36 hrs Surf.Area= 12,071 sf Storage= 46,990 cf

Plug-Flow detention time= 373.2 min calculated for 0.905 af (53% of inflow)

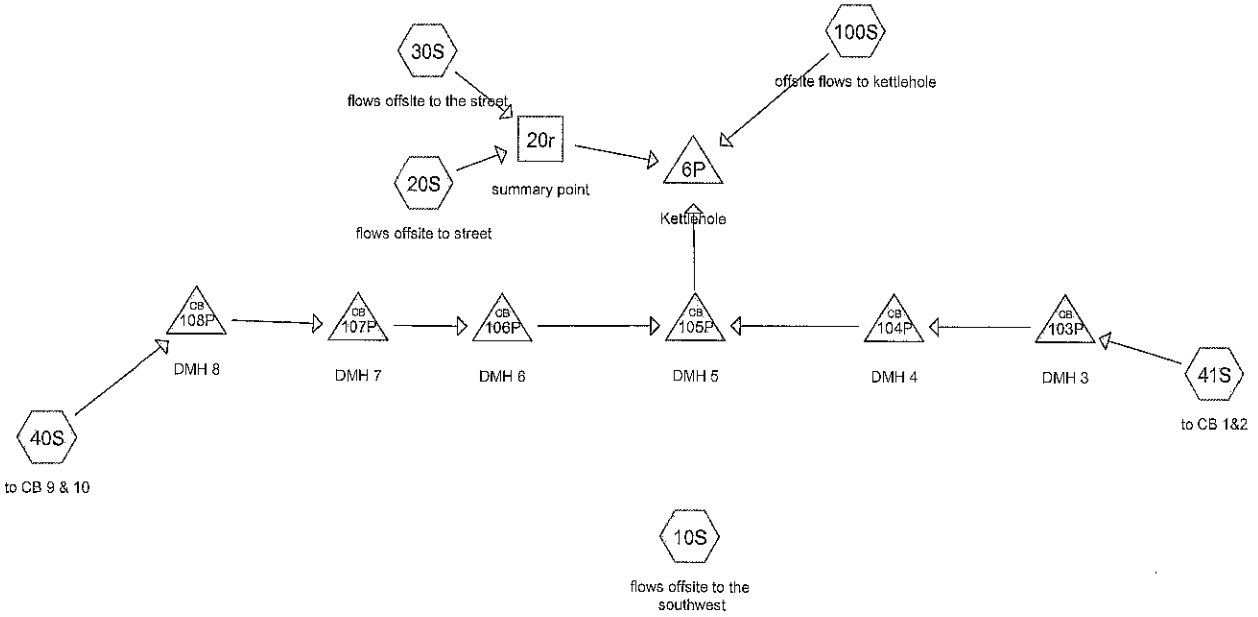
Center-of-Mass det. time= 250.0 min (1,094.2 - 844.2)

Volume	Invert	Avail.Storage	Storage Description
#1	173.00'	110,561 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
173.00	77	0	0
174.00	505	291	291
175.00	3,182	1,844	2,135
176.00	4,540	3,861	5,996
177.00	6,045	5,293	11,288
178.00	7,500	6,773	18,061
180.00	10,000	17,500	35,561
185.00	20,000	75,000	110,561

Device	Routing	Invert	Outlet Devices
#1	Discarded	173.00'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 163.00'

Discarded OutFlow Max=0.9 cfs @ 16.36 hrs HW=181.04' (Free Discharge)
↑**1=Exfiltration** (Controls 0.9 cfs)



Subcat Reach Pond Link

Routing Diagram for 5204 post 4-14-17
Prepared by Places Associates Inc., Printed 4/14/2017

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.350	49	50-75% Grass cover, Fair, HSG A (10S, 20S, 30S, 40S, 41S, 100S)
4.480	98	Paved parking, HSG A (30S, 40S, 41S, 100S)
0.220	98	Unconnected roofs, HSG A (10S, 20S)
4.450	36	Woods, Fair, HSG A (10S, 20S, 30S, 40S, 100S)
12.500	**63**	**TOTAL AREA**

Summary for Subcatchment 10S: flows offsite to the southwest

Runoff = 0.0 cfs @ 22.93 hrs, Volume= 0.001 af, Depth> 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Adj	Description
0.400	49		50-75% Grass cover, Fair, HSG A
1.100	36		Woods, Fair, HSG A
0.100	98		Unconnected roofs, HSG A
1.600	43	41	Weighted Average, UI Adjusted
1.500			93.75% Pervious Area
0.100			6.25% Impervious Area
0.100			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.5	350	Total			

Summary for Subcatchment 20S: flows offsite to street

Runoff = 0.0 cfs @ 14.81 hrs, Volume= 0.005 af, Depth= 0.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Adj	Description
0.120	98		Unconnected roofs, HSG A
0.350	36		Woods, Fair, HSG A
0.380	49		50-75% Grass cover, Fair, HSG A
0.850	51	47	Weighted Average, UI Adjusted
0.730			85.88% Pervious Area
0.120			14.12% Impervious Area
0.120			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	30	0.0300	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.1	35	0.7000	4.18		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.1	65	Total			

Summary for Subcatchment 30S: flows offsite to the street

Runoff = 1.4 cfs @ 12.10 hrs, Volume= 0.103 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Description
0.580	98	Paved parking, HSG A
0.100	36	Woods, Fair, HSG A
0.160	49	50-75% Grass cover, Fair, HSG A
0.840	81	Weighted Average
0.260		30.95% Pervious Area
0.580		69.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 40S: to CB 9 & 10

Runoff = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Description
0.850	98	Paved parking, HSG A
0.100	36	Woods, Fair, HSG A
1.260	49	50-75% Grass cover, Fair, HSG A
2.210	67	Weighted Average
1.360		61.54% Pervious Area
0.850		38.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 41S: to CB 1&2

Runoff = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af, Depth= 0.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Description
0.650	98	Paved parking, HSG A
0.750	49	50-75% Grass cover, Fair, HSG A
1.400	72	Weighted Average
0.750		53.57% Pervious Area
0.650		46.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 100S: offsite flows to kettlehole

Runoff = 2.7 cfs @ 12.12 hrs, Volume= 0.261 af, Depth= 0.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.20"

Area (ac)	CN	Description
2.400	98	Paved parking, HSG A
2.800	36	Woods, Fair, HSG A
0.400	49	50-75% Grass cover, Fair, HSG A
5.600	64	Weighted Average
3.200		57.14% Pervious Area
2.400		42.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 20r: summary point

Inflow Area = 1.690 ac, 41.42% Impervious, Inflow Depth = 0.77" for 2 year event
Inflow = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af
Outflow = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Summary for Pond 6P: Kettlehole

Inflow Area = 10.900 ac, 42.20% Impervious, Inflow Depth = 0.66" for 2 year event
Inflow = 7.0 cfs @ 12.11 hrs, Volume= 0.604 af
Outflow = 0.4 cfs @ 15.97 hrs, Volume= 0.423 af, Atten= 94%, Lag= 231.5 min
Discarded = 0.4 cfs @ 15.97 hrs, Volume= 0.423 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 177.36' @ 15.97 hrs Surf.Area= 6,566 sf Storage= 13,545 cf

Plug-Flow detention time= 326.1 min calculated for 0.422 af (70% of inflow)
Center-of-Mass det. time= 217.5 min (1,100.2 - 882.7)

Volume	Invert	Avail.Storage	Storage Description
#1	173.00'	110,561 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
173.00	77	0	0
174.00	505	291	291
175.00	3,182	1,844	2,135
176.00	4,540	3,861	5,996
177.00	6,045	5,293	11,288
178.00	7,500	6,773	18,061
180.00	10,000	17,500	35,561
185.00	20,000	75,000	110,561

Device	Routing	Invert	Outlet Devices
#1	Discarded	173.00'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 163.00'

Discarded OutFlow Max=0.4 cfs @ 15.97 hrs HW=177.36' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.4 cfs)

Summary for Pond 103P: DMH 3

Inflow Area = 1.400 ac, 46.43% Impervious, Inflow Depth = 0.93" for 2 year event
Inflow = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af
Outflow = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af, Atten= 0%, Lag= 0.0 min
Primary = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 203.02' @ 12.10 hrs
Flood Elev= 207.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	202.40'	**12.0" Round Culvert** L= 172.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 202.40' / 200.68' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.4 cfs @ 12.10 hrs HW=203.02' TW=201.20' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.4 cfs @ 2.69 fps)

Summary for Pond 104P: DMH 4

Inflow Area = 1.400 ac, 46.43% Impervious, Inflow Depth = 0.93" for 2 year event
Inflow = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af
Outflow = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af, Atten= 0%, Lag= 0.0 min
Primary = 1.4 cfs @ 12.10 hrs, Volume= 0.108 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Peak Elev= 201.20' @ 12.10 hrs
Flood Elev= 207.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	200.58'	**12.0" Round Culvert** L= 115.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 200.58' / 199.43' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.4 cfs @ 12.10 hrs HW=201.20' TW=195.21' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.4 cfs @ 2.69 fps)

Summary for Pond 105P: DMH 5

Inflow Area = 3.610 ac, 41.55% Impervious, Inflow Depth = 0.78" for 2 year event
Inflow = 2.9 cfs @ 12.11 hrs, Volume= 0.235 af
Outflow = 2.9 cfs @ 12.11 hrs, Volume= 0.235 af, Atten= 0%, Lag= 0.0 min
Primary = 2.9 cfs @ 12.11 hrs, Volume= 0.235 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 195.21' @ 12.11 hrs
Flood Elev= 206.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	194.42'	**18.0" Round Culvert** L= 82.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 194.42' / 193.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=2.8 cfs @ 12.11 hrs HW=195.20' TW=175.36' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.8 cfs @ 3.01 fps)

Summary for Pond 106P: DMH 6

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 0.69" for 2 year event
Inflow = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af
Outflow = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af, Atten= 0%, Lag= 0.0 min
Primary = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 203.90' @ 12.11 hrs
Flood Elev= 207.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	203.25'	**12.0" Round Culvert** L= 121.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 203.25' / 202.04' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.4 cfs @ 12.11 hrs HW=203.89' TW=195.20' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.4 cfs @ 2.72 fps)

Summary for Pond 107P: DMH 7

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 0.69" for 2 year event
Inflow = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af
Outflow = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af, Atten= 0%, Lag= 0.0 min
Primary = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 204.72' @ 12.11 hrs
Flood Elev= 208.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	204.07'	**12.0" Round Culvert** L= 72.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 204.07' / 203.35' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.4 cfs @ 12.11 hrs HW=204.71' TW=203.89' (Dynamic Tailwater)
↑**1=Culvert** (Outlet Controls 1.4 cfs @ 3.73 fps)

Summary for Pond 108P: DMH 8

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 0.69" for 2 year event
Inflow = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af
Outflow = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af, Atten= 0%, Lag= 0.0 min
Primary = 1.5 cfs @ 12.11 hrs, Volume= 0.127 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 205.95' @ 12.11 hrs
Flood Elev= 209.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	205.30'	**12.0" Round Culvert** L= 113.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 205.30' / 204.17' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.4 cfs @ 12.11 hrs HW=205.94' TW=204.71' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 1.4 cfs @ 2.72 fps)

Summary for Subcatchment 10S: flows offsite to the southwest

Runoff = 0.0 cfs @ 13.81 hrs, Volume= 0.022 af, Depth> 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Adj	Description
0.400	49		50-75% Grass cover, Fair, HSG A
1.100	36		Woods, Fair, HSG A
0.100	98		Unconnected roofs, HSG A
1.600	43	41	Weighted Average, UI Adjusted
1.500			93.75% Pervious Area
0.100			6.25% Impervious Area
0.100			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.5	350	Total			

Summary for Subcatchment 20S: flows offsite to street

Runoff = 0.1 cfs @ 12.34 hrs, Volume= 0.026 af, Depth= 0.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Adj	Description
0.120	98		Unconnected roofs, HSG A
0.350	36		Woods, Fair, HSG A
0.380	49		50-75% Grass cover, Fair, HSG A
0.850	51	47	Weighted Average, UI Adjusted
0.730			85.88% Pervious Area
0.120			14.12% Impervious Area
0.120			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	30	0.0300	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.1	35	0.7000	4.18		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.1	65	Total			

Summary for Subcatchment 30S: flows offsite to the street

Runoff = 2.5 cfs @ 12.09 hrs, Volume= 0.178 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Description
0.580	98	Paved parking, HSG A
0.100	36	Woods, Fair, HSG A
0.160	49	50-75% Grass cover, Fair, HSG A
0.840	81	Weighted Average
0.260		30.95% Pervious Area
0.580		69.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 40S: to CB 9 & 10

Runoff = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af, Depth= 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Description
0.850	98	Paved parking, HSG A
0.100	36	Woods, Fair, HSG A
1.260	49	50-75% Grass cover, Fair, HSG A
2.210	67	Weighted Average
1.360		61.54% Pervious Area
0.850		38.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 41S: to CB 1&2

Runoff = 2.9 cfs @ 12.10 hrs, Volume= 0.212 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Description
0.650	98	Paved parking, HSG A
0.750	49	50-75% Grass cover, Fair, HSG A
1.400	72	Weighted Average
0.750		53.57% Pervious Area
0.650		46.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 100S: offsite flows to kettlehole

Runoff = 7.5 cfs @ 12.10 hrs, Volume= 0.591 af, Depth= 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.50"

Area (ac)	CN	Description
2.400	98	Paved parking, HSG A
2.800	36	Woods, Fair, HSG A
0.400	49	50-75% Grass cover, Fair, HSG A
5.600	64	Weighted Average
3.200		57.14% Pervious Area
2.400		42.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 20r: summary point

Inflow Area = 1.690 ac, 41.42% Impervious, Inflow Depth = 1.45" for 10 year event
Inflow = 2.5 cfs @ 12.10 hrs, Volume= 0.205 af
Outflow = 2.5 cfs @ 12.10 hrs, Volume= 0.205 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Summary for Pond 6P: Kettlehole

Inflow Area = 10.900 ac, 42.20% Impervious, Inflow Depth = 1.41" for 10 year event
Inflow = 16.4 cfs @ 12.10 hrs, Volume= 1.277 af
Outflow = 0.7 cfs @ 16.57 hrs, Volume= 0.711 af, Atten= 96%, Lag= 267.9 min
Discarded = 0.7 cfs @ 16.57 hrs, Volume= 0.711 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 179.78' @ 16.57 hrs Surf.Area= 9,726 sf Storage= 33,401 cf

Plug-Flow detention time= 367.7 min calculated for 0.709 af (56% of inflow)
Center-of-Mass det. time= 242.3 min (1,102.5 - 860.2)

Volume	Invert	Avail.Storage	Storage Description
#1	173.00'	110,561 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
173.00	77	0	0
174.00	505	291	291
175.00	3,182	1,844	2,135
176.00	4,540	3,861	5,996
177.00	6,045	5,293	11,288
178.00	7,500	6,773	18,061
180.00	10,000	17,500	35,561
185.00	20,000	75,000	110,561

Device	Routing	Invert	Outlet Devices
#1	Discarded	173.00'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 163.00'

Discarded OutFlow Max=0.7 cfs @ 16.57 hrs HW=179.78' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.7 cfs)

Summary for Pond 103P: DMH 3

Inflow Area = 1.400 ac, 46.43% Impervious, Inflow Depth = 1.82" for 10 year event
Inflow = 2.9 cfs @ 12.10 hrs, Volume= 0.212 af
Outflow = 2.9 cfs @ 12.10 hrs, Volume= 0.212 af, Atten= 0%, Lag= 0.0 min
Primary = 2.9 cfs @ 12.10 hrs, Volume= 0.212 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 203.48' @ 12.10 hrs
Flood Elev= 207.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	202.40'	**12.0" Round Culvert** L= 172.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 202.40' / 200.68' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.9 cfs @ 12.10 hrs HW=203.47' TW=201.65' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.9 cfs @ 3.64 fps)

Summary for Pond 104P: DMH 4

Inflow Area = 1.400 ac, 46.43% Impervious, Inflow Depth = 1.82" for 10 year event
Inflow = 2.9 cfs @ 12.10 hrs, Volume= 0.212 af
Outflow = 2.9 cfs @ 12.10 hrs, Volume= 0.212 af, Atten= 0%, Lag= 0.0 min
Primary = 2.9 cfs @ 12.10 hrs, Volume= 0.212 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Peak Elev= 201.66' @ 12.10 hrs
Flood Elev= 207.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	200.58'	**12.0" Round Culvert** L= 115.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 200.58' / 199.43' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.9 cfs @ 12.10 hrs HW=201.65' TW=195.73' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.9 cfs @ 3.64 fps)

Summary for Pond 105P: DMH 5

Inflow Area = 3.610 ac, 41.55% Impervious, Inflow Depth = 1.60" for 10 year event
Inflow = 6.4 cfs @ 12.10 hrs, Volume= 0.482 af
Outflow = 6.4 cfs @ 12.10 hrs, Volume= 0.482 af, Atten= 0%, Lag= 0.0 min
Primary = 6.4 cfs @ 12.10 hrs, Volume= 0.482 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 195.74' @ 12.10 hrs
Flood Elev= 206.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	194.42'	**18.0" Round Culvert** L= 82.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 194.42' / 193.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=6.4 cfs @ 12.10 hrs HW=195.73' TW=176.81' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 6.4 cfs @ 5.20 fps)

Summary for Pond 106P: DMH 6

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 1.46" for 10 year event
Inflow = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af
Outflow = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af, Atten= 0%, Lag= 0.0 min
Primary = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 204.71' @ 12.10 hrs
Flood Elev= 207.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	203.25'	**12.0" Round Culvert** L= 121.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 203.25' / 202.04' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.5 cfs @ 12.10 hrs HW=204.71' TW=195.74' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 3.5 cfs @ 4.50 fps)

Summary for Pond 107P: DMH 7

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 1.46" for 10 year event
Inflow = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af
Outflow = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af, Atten= 0%, Lag= 0.0 min
Primary = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 205.63' @ 12.13 hrs
Flood Elev= 208.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	204.07'	**12.0" Round Culvert** L= 72.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 204.07' / 203.35' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.0 cfs @ 12.10 hrs HW=205.56' TW=204.71' (Dynamic Tailwater)
↑**1=Culvert** (Outlet Controls 3.0 cfs @ 3.82 fps)

Summary for Pond 108P: DMH 8

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 1.46" for 10 year event
Inflow = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af
Outflow = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af, Atten= 0%, Lag= 0.0 min
Primary = 3.5 cfs @ 12.10 hrs, Volume= 0.270 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 206.81' @ 12.12 hrs
Flood Elev= 209.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	205.30'	**12.0" Round Culvert** L= 113.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 205.30' / 204.17' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.1 cfs @ 12.10 hrs HW=206.79' TW=205.56' (Dynamic Tailwater)
↑**1=Culvert** (Outlet Controls 3.1 cfs @ 3.95 fps)

Summary for Subcatchment 10S: flows offsite to the southwest

Runoff = 0.5 cfs @ 12.47 hrs, Volume= 0.097 af, Depth> 0.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Adj	Description
0.400	49		50-75% Grass cover, Fair, HSG A
1.100	36		Woods, Fair, HSG A
0.100	98		Unconnected roofs, HSG A
1.600	43	41	Weighted Average, UI Adjusted
1.500			93.75% Pervious Area
0.100			6.25% Impervious Area
0.100			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
10.0	300	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.5	350	Total			

Summary for Subcatchment 20S: flows offsite to street

Runoff = 0.8 cfs @ 12.13 hrs, Volume= 0.082 af, Depth= 1.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Adj	Description
0.120	98		Unconnected roofs, HSG A
0.350	36		Woods, Fair, HSG A
0.380	49		50-75% Grass cover, Fair, HSG A
0.850	51	47	Weighted Average, UI Adjusted
0.730			85.88% Pervious Area
0.120			14.12% Impervious Area
0.120			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	30	0.0300	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.1	35	0.7000	4.18		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.1	65	Total			

Summary for Subcatchment 30S: flows offsite to the street

Runoff = 4.1 cfs @ 12.09 hrs, Volume= 0.304 af, Depth= 4.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Description
0.580	98	Paved parking, HSG A
0.100	36	Woods, Fair, HSG A
0.160	49	50-75% Grass cover, Fair, HSG A
0.840	81	Weighted Average
0.260		30.95% Pervious Area
0.580		69.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 40S: to CB 9 & 10

Runoff = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Description
0.850	98	Paved parking, HSG A
0.100	36	Woods, Fair, HSG A
1.260	49	50-75% Grass cover, Fair, HSG A
2.210	67	Weighted Average
1.360		61.54% Pervious Area
0.850		38.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 41S: to CB 1&2

Runoff = 5.5 cfs @ 12.09 hrs, Volume= 0.397 af, Depth= 3.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Description
0.650	98	Paved parking, HSG A
0.750	49	50-75% Grass cover, Fair, HSG A
1.400	72	Weighted Average
0.750		53.57% Pervious Area
0.650		46.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 100S: offsite flows to kettlehole

Runoff = 16.6 cfs @ 12.10 hrs, Volume= 1.226 af, Depth= 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=6.50"

Area (ac)	CN	Description
2.400	98	Paved parking, HSG A
2.800	36	Woods, Fair, HSG A
0.400	49	50-75% Grass cover, Fair, HSG A
5.600	64	Weighted Average
3.200		57.14% Pervious Area
2.400		42.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 20r: summary point

Inflow Area = 1.690 ac, 41.42% Impervious, Inflow Depth = 2.74" for 100 year event
Inflow = 4.9 cfs @ 12.10 hrs, Volume= 0.386 af
Outflow = 4.9 cfs @ 12.10 hrs, Volume= 0.386 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Summary for Pond 6P: Kettlehole

Inflow Area = 10.900 ac, 42.20% Impervious, Inflow Depth = 2.80" for 100 year event
Inflow = 34.4 cfs @ 12.10 hrs, Volume= 2.546 af
Outflow = 1.2 cfs @ 16.72 hrs, Volume= 1.227 af, Atten= 97%, Lag= 277.6 min
Discarded = 1.2 cfs @ 16.72 hrs, Volume= 1.227 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 182.85' @ 16.72 hrs Surf.Area= 15,691 sf Storage= 72,116 cf

Plug-Flow detention time= 380.1 min calculated for 1.224 af (48% of inflow)
Center-of-Mass det. time= 257.3 min (1,098.0 - 840.7)

Volume	Invert	Avail.Storage	Storage Description
#1	173.00'	110,561 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
173.00	77	0	0
174.00	505	291	291
175.00	3,182	1,844	2,135
176.00	4,540	3,861	5,996
177.00	6,045	5,293	11,288
178.00	7,500	6,773	18,061
180.00	10,000	17,500	35,561
185.00	20,000	75,000	110,561

Device	Routing	Invert	Outlet Devices
#1	Discarded	173.00'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 163.00'

Discarded OutFlow Max=1.2 cfs @ 16.72 hrs HW=182.85' (Free Discharge)
↑—**1=Exfiltration** (Controls 1.2 cfs)

Summary for Pond 103P: DMH 3

Inflow Area = 1.400 ac, 46.43% Impervious, Inflow Depth = 3.41" for 100 year event
Inflow = 5.5 cfs @ 12.09 hrs, Volume= 0.397 af
Outflow = 5.5 cfs @ 12.09 hrs, Volume= 0.397 af, Atten= 0%, Lag= 0.0 min
Primary = 5.5 cfs @ 12.09 hrs, Volume= 0.397 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 208.80' @ 12.11 hrs
Flood Elev= 207.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	202.40'	**12.0" Round Culvert** L= 172.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 202.40' / 200.68' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=4.9 cfs @ 12.09 hrs HW=208.33' TW=204.17' (Dynamic Tailwater)
↑—**1=Culvert** (Outlet Controls 4.9 cfs @ 6.23 fps)

Summary for Pond 104P: DMH 4

Inflow Area = 1.400 ac, 46.43% Impervious, Inflow Depth = 3.41" for 100 year event
Inflow = 5.5 cfs @ 12.09 hrs, Volume= 0.397 af
Outflow = 5.5 cfs @ 12.09 hrs, Volume= 0.397 af, Atten= 0%, Lag= 0.0 min
Primary = 5.5 cfs @ 12.09 hrs, Volume= 0.397 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

Peak Elev= 204.29' @ 12.09 hrs
Flood Elev= 207.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	200.58'	**12.0" Round Culvert** L= 115.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 200.58' / 199.43' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=5.4 cfs @ 12.09 hrs HW=204.17' TW=197.48' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 5.4 cfs @ 6.87 fps)

Summary for Pond 105P: DMH 5

Inflow Area = 3.610 ac, 41.55% Impervious, Inflow Depth = 3.10" for 100 year event
Inflow = 12.8 cfs @ 12.09 hrs, Volume= 0.934 af
Outflow = 12.8 cfs @ 12.09 hrs, Volume= 0.934 af, Atten= 0%, Lag= 0.0 min
Primary = 12.8 cfs @ 12.09 hrs, Volume= 0.934 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 197.55' @ 12.10 hrs
Flood Elev= 206.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	194.42'	**18.0" Round Culvert** L= 82.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 194.42' / 193.60' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=12.7 cfs @ 12.09 hrs HW=197.49' TW=178.98' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 12.7 cfs @ 7.16 fps)

Summary for Pond 106P: DMH 6

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 2.91" for 100 year event
Inflow = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af
Outflow = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af, Atten= 0%, Lag= 0.0 min
Primary = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 210.24' @ 12.10 hrs
Flood Elev= 207.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	203.25'	**12.0" Round Culvert** L= 121.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 203.25' / 202.04' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=7.3 cfs @ 12.10 hrs HW=210.08' TW=197.50' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 7.3 cfs @ 9.25 fps)

Summary for Pond 107P: DMH 7

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 2.91" for 100 year event
Inflow = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af
Outflow = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af, Atten= 0%, Lag= 0.0 min
Primary = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 214.17' @ 12.13 hrs
Flood Elev= 208.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	204.07'	**12.0" Round Culvert** L= 72.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 204.07' / 203.35' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=5.8 cfs @ 12.10 hrs HW=213.30' TW=210.08' (Dynamic Tailwater)
↑**1=Culvert** (Outlet Controls 5.8 cfs @ 7.43 fps)

Summary for Pond 108P: DMH 8

Inflow Area = 2.210 ac, 38.46% Impervious, Inflow Depth = 2.91" for 100 year event
Inflow = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af
Outflow = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af, Atten= 0%, Lag= 0.0 min
Primary = 7.3 cfs @ 12.10 hrs, Volume= 0.537 af

Routing by Dyn-Stor-Ind method, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Peak Elev= 218.36' @ 12.15 hrs
Flood Elev= 209.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	205.30'	**12.0" Round Culvert** L= 113.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 205.30' / 204.17' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=4.4 cfs @ 12.10 hrs HW=215.73' TW=213.30' (Dynamic Tailwater)
↑**1=Culvert** (Outlet Controls 4.4 cfs @ 5.57 fps)